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VOLUME XIX. SAN FRANCISCO, CAL., DECEMBER 14, 1907 No. 24

ELECTRIC ARCH ILLUMINATION

One of the most interesting street lighting installations ever made is that just completed on Fillmore street, in San Francisco. After the great fire of April, 1906, this formerly quiet neighborhood business street, devoted to the corner grocery, notion and candy store, was suddenly called upon to take care of every great business interest of a city whose inhabitants were at that time the world's greatest buyers. Its facilities for handling this business, small as they were, were the only ones immediately available.

NEW ELECTRIC ARCHES ON FILLMORE STREET, SAN FRANCISCO

But in the process of reconstruction new and larger quarters have been found by many firms, and in order to retain a part of its former glory, the Fillmore Street Improvement Association recognized the need of adequate lighting. Welsbach lights frequently interspersed gave good service for local effects, but the suspended arc light at each corner did not prove ample for general illumination. Consequently the experience obtained by the previous lighting effects used at various large conventions that had been held in San Francisco was called upon, and the system of arches shown in the accompanying illustrations was devised.

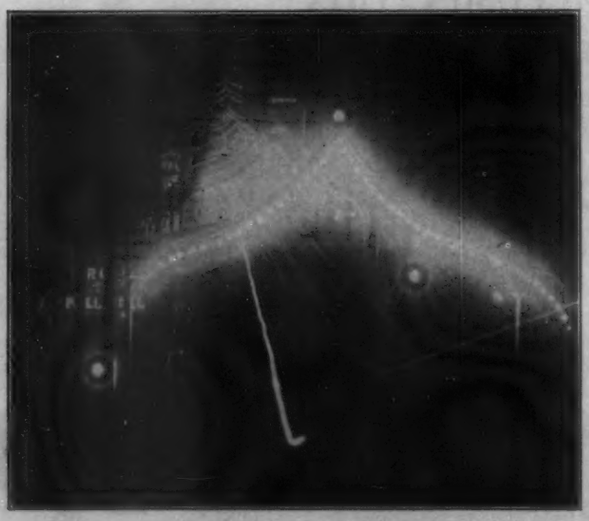
Fillmore street is but forty-two feet from curb to curb, and is the main cross-town artery of the city. The Fillmore-street tracks of the United Railroads occupy the center of the street. Nine of the fourteen street crossings covered by the arches are used by street railways, two being cable and seven electric. The high-tension overhead transmission lines of both the United Railroads and the San Francisco Gas and Electric Company are strung along this street, as is also a network of telephone and telegraph wires. The difficulties of placing these arches can be pictured when it is known that all the work was done in two weeks, working in the day time only with thirty men, without in any way interrupting the street traffic.

Four iron poles were placed at each crossing, being four feet in the ground and sixteen feet high. A gin pole was put up in the center of the street and each of the four latticed steel girder sections was fastened in place. They were then painted white with lead-color butts, a clear-headed sailor doing the work. All being in readiness, the lamps were inserted in their sockets and the wiring connections made. This work of construction was done by the Butte Engineering and Electric Company. The top of

each arch is forty feet above the center of the street, the span being forty-two feet.

There are one hundred and twenty 16 c.p.-110 volt incandescent lamps on each of the fourteen arches, making a total of 1680 Sunbeam lamps furnished by the California Electrical Works. These lamps are of the single anchor, carbon filament type, and are not especially designed for outside work. Each arch is surmounted by a 50 c.p. lamp in a white globe.

The Fillmore Street Improvement Association has borne the $12,500 expense of this installation with the understanding that the current cost will be paid by the city.



GENERAL EFFECT OF FILLMORE STREET ARCHES

The excellence of the general illumination is shown in the detail of the illustration, given by a six-minute exposure. The beauty and brilliancy of the effect of this wonderful electric arch gives an added attractiveness to the street.

The illustrations also show the great extent to which the incandescent light is being applied to store and sign illumination, particularly the latter. There is no other single factor that has contributed to the increased current consumption than this cause. The long white streaks in the pictures are due to the moving headlights of automobiles or street cars.

Los Angeles.—Representatives of the public utility companies in Los Angeles have asked the Board of Public Works to have the conduit ordinance changed so that the companies, instead of installing conduits along two miles of streets each year, they may lay four miles in two years or ten miles in five years. In this request they set forth the fact that the expense of laying two miles of conduit each year is much greater than if they were given a longer time in which to lay a greater number of miles. The Board of Public Works declined to make the recommendation to the Council but agreed not to oppose it if the initiative should be taken in some other quarter, and it is probable that the Municipal League will be asked to make the recommendation to the Council.

THE INDUCTION MOTOR AS A PHASE CONVERTER.

By C. C. Batchelder.

Converting from one polyphase system to another having a different number of phases is a problem which can always be solved by the use of transformers, since in the original system there must be two components of electromotive force in quadrature, and by varying the values of these components a resultant of any desired phase can be obtained; but a single-phase system can not be converted into a polyphase system by such simple apparatus, because the quadrature component must be supplied by some auxiliary means.

Also since the energy flow is pulsating in a single phase and steady in a polyphase system, conversion from the former to the latter requires apparatus which can store energy while the single-phase input exceeds the polyphase output, and give up this energy into the polyphase system during that part of the cycle when the input falls below the output. In phase-splitting devices employing inductance or capacity, an electromotive force in quadrature with the impressed electromotive force is obtained from the reactive drop of the current flowing through an inductive winding, or into a condenser, as the case may be; and the necessary energy is stored as magnetic energy, $\frac{I^2L}{2}$, in the core of the winding, or as electrostatic energy, $\frac{E^2C}{2}$, in the dielectric of the condenser; but such devices are inefficient and costly and are used only for such intermittent work as starting single-phase motors. The requirements are most satisfactorily met by induction and synchronous motors, which, by means of their rotating magnetic fields, can supply the electromotive forces and currents displaced in phase from those of the primary system, and can receive kinetic energy into their rotating parts and return this to the system as electrical energy when needed. Such machines are known as phase converters.

The possible use of the induction motor as a phase converter depends upon the fact, that the magnetic conditions existing in the single-phase induction motor when running near synchronism approach those of the polyphase motor; that is, the field of the single-phase motor has two components approximately in quadrature as to time and space. So if a motor having a polyphase primary winding be run single phase, there will be induced in the "idle" windings electromotive forces which are dependent in phase upon the angular displacement of these windings from the primary phase; thus, a three-phase motor when run single phase gives three-phase electromotive force at its terminals; a two-phase motor, two-phase electromotive force, etc.

The induction motor, when used in this manner, presents an instance of double transformation, in which energy is first transformed from one primary phase of the motor to the secondary or armature, and from there transformed into the other primary windings, which are known as the tertiary windings. Since the induction motor has compara-

tively poor regulation as a transformer, due to the unavoidable leakage of magnetic flux in the airgap, it is apparent that this double transformation can be accomplished only at the cost of appreciable loss of voltage, so that the resulting polyphase system must necessarily be somewhat unsymmetrical; the inequality of the resulting voltages depending on the self-induction and resistance of the field and armature windings.

Graphically the phenomena may be represented as in Figure 1. Let Φ_1 be the magnetic flux interlinked with both primary and secondary, or rotor, circuits. Then E_1' is the

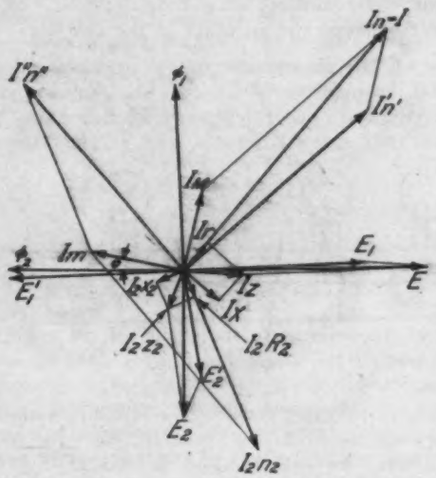


FIG. 1.

electromotive force induced in the primary, which must be overcome by an equal and opposite component of primary impressed electromotive force E_1. The quadrature magnetic flux is represented by Φ_2 nearly 90 degrees behind Φ_1, and of somewhat lesser magnitude on account of the resistance and reactance of the rotor. The quadrature flux Φ_2 interlinks with the secondary and tertiary circuits, inducing in the latter the electromotive force E_2. This electromotive force is impressed upon a circuit whose impedance is equal to the sum of the internal impedance of the winding

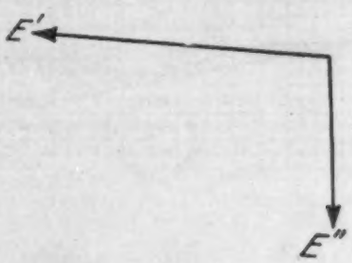


FIG. 2.

and the impedance of the receiving circuit, and causes a current I_2 to flow. The electromotive force consumed in forcing this current through the internal impedance is the resultant of the electromotive force I_2R_2 required to overcome the resistance, and which is in phase with the current, and the electromotive force I_2X_2 required to overcome the reactance, and which leads the current by 90 degrees. The resultant internal drop I_2Z_2 when subtracted from the induced electromotive force E_2 gives E_2', the electromotive force at the terminals of the receiving circuit.

The magnetomotive force required to produce the flux Φ_2 is Im, which leads the flux by the angle **a**, the angle of hysteretic advance. The magnetomotive force of the tertiary winding is I_2n_2, n_2 being the number of turns in the winding. The magnetomotive force of the secondary will be of such magnitude and phase that when combined with the tertiary magnetomotive force, the resultant will be Im; this is therefore represented by I''n''. The effect of this magnetomotive force on the primary is that of an equal magnetomotive force I'n' 90 degrees ahead of I''n'' in time and space. The phase of this magnetomotive force I'n' has been determined from the standpoint of the machine acting as a generator; if, therefore, we reverse it, it will represent the magnetomotive force of the secondary as referred to the primary, as an input or motor phase. So reversing a second time to obtain the primary balancing magnetomotive force, we have I'n' as the component of primary magnetomotive force required to overcome that of the secondary. Im is the magnetomotive force required to produce the main flux Φ_1, therefore the total primary magnetomotive force is In. Since, as shown in the diagram, the tertiary magnetomotive force I_2n_2 was drawn equal to I_0, and since in all practical motors the number of turns in the tertiary equals the number in the primary, In = I, the primary current. The primary resistance and reactance must be overcome in forcing this current through the primary winding, and this requires the components of impressed electromotive force IR in phase with, and IX 90 degrees ahead of the current. Adding the resultant of these, IZ, to the electromotive force required to overcome the primary in-

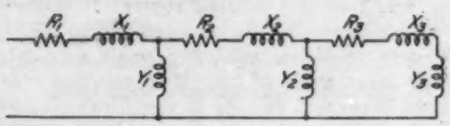


FIG. 3.

duced electromotive force E_1, we obtain E as the primary impressed electromotive force. The electromotive forces of the quarter-phase system are E' and E'', in Figure 2, E' being the reverse of E in Figure 1, since the latter was plotted when considering the machine as a motor.

The phase converter is the equivalent in its electrical and magnetic quantities to a divided circuit represented diagramatically in Figure 3, where R_1 and X_1 are the primary resistance and reactance respectively, R_2 and X_2 the secondary resistance and reactance and R_3 and X_3 the same quantities for the tertiary. Y_1 is the primary exciting admittance, Y_2 the quadrature exciting admittance, and Y_3 the admittance of the receiving circuit. Then if I_1, I_2 and I_3 are

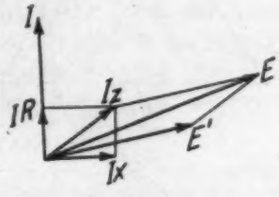


FIG. 4.

the currents in the respective branches, the total current input I is $I_1 + I_2 + I_3$ added vectorially.

Let E=voltage impressed on motor, E_1 =voltage across Y_1, E_2 across Y_2 and E_3 across Y_3.

Then, vectorially

$$\begin{aligned} I &= I_1 + I_2 + I_3 \\ &= E_1Y_1 + E_2Y_2 + E_3Y_3 \\ E_2 &= E_3 + I_3Z_3 \\ E_1 &= E_2 + (I_2 + I_3)Z_2 \\ E &= E_1 + (I_1 + I_2 + I_3)Z_1 \end{aligned} \qquad (1)$$

The value of the resultant voltages in the case of a three-phase motor is made clearer by a further study of the vector diagram of the quantities involved. Let a Voltage E be impressed on the primary phase of such a phase converter (Fig. 4). Then a magnetizing current I will flow in

the winding. The impedance drop due to this current is IZ, so the voltage induced in the winding is represented by E'. Now the quadrature voltage is 90 degrees behind the induced voltage, therefore it is somewhat less than 90 degrees behind the impressed voltage, and the voltage triangle will be somewhat distorted, as shown in Figure 5, even with no load on the tertiary phases. Now as the machine is loaded the current I shifts more and more toward the induced voltage E', and this throws the impressed voltage ahead of E. This is equivalent to increasing the angle **a**, and it is evident that at some value of the current, **a** will pass through 90 degrees, and the voltage triangle will be distorted in the opposite direction. If the load on the machine be inductive, the current required to make **a** = 90 degrees will evidently be larger than that required if the load be non-inductive, and

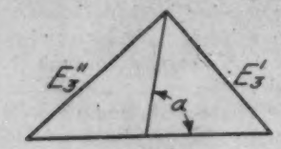


FIG. 5.

the opposite is true if a leading current is taken from the machine. Moreover, in the case of large machines with small air gaps requiring relatively small magnetizing currents, with a large angle of hysteretic advance, it is improbable that the impressed voltage E would ever lag behind the induced voltage E'; so that the distortion of the voltage triangle would always be in the same direction, except when a large inductive load was drawn from the tertiary windings. In the case of most small machines, however, this change of direction of distortion is very likely to occur.

The impedance of the tertiary phases results in a further distortion of the electromotive force triangle. Let the voltages induced in the tertiary windings and the voltages impressed on the primary be as shown in Figure 6: this will represent the no-load terminal voltage of the phase

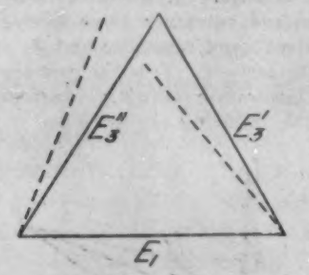


FIG. 6.

converter. As the machine is loaded up the reactance of the tertiary will cause the terminal voltage to lag behind E_3' and E_3'', tending to assume the values and phase indicated by the dotted lines. Since, however, the terminals of the two tertiary phases are connected, and, therefore, at the same potential, the terminal voltages coincide and give a resultant triangle, as shown in Figure 7; where the dotted lines represent the no-load voltage of Figure 6, and the full lines the voltage with load on the machine. This unbalancing can be produced only by unequal division of the current between the two phases, so that in a phase converter with load the current is unequally divided between the two tertiary phases.

For the purpose of calculation, however, it can be assumed without introducing serious inaccuracy that the current divides equally between the two tertiary legs. Under these conditions the resultant impedance drop in the windings, due to the current flowing in the third line, is equal to the product of this current and half the impedance of one winding of the machine, since the current in one leg equals the current in the third line divided by the $\sqrt{3}$, and the drop in one leg must be multiplied by $\frac{\sqrt{3}}{2}$ to give the resultant drop at right angles to the impressed primary voltage; that is, if I = current in third line $\frac{I}{\sqrt{3}}$ = current in each leg of winding, and $\frac{I}{\sqrt{3}} \times$ (impedance of one phase) $\times \frac{\sqrt{3}}{2}$ = resultant quarterphase drop = $\frac{IZ}{2}$

This expression is slightly inaccurate since it assumes a balanced electromotive force triangle; i. e., an angle of 120 degrees between the currents in the two legs; but since

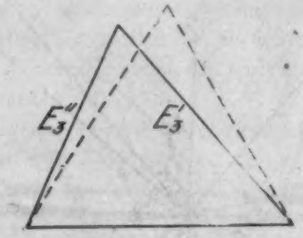


FIG. 7.

the error is proportional to the cosine of the angle of variation, and not to the angle itself, it is not of very great magnitude.

Therefore, to calculate the resultant terminal voltages under varying conditions of load in the case of a three phase machine, we can proceed as indicated in equation (1), by using for Z, the primary impedance, 2/3 the impedance of one phase of the winding, and for Z_3, the tertiary impedance, 1/3 the impedance of one coil; and in the case of a two phase motor, by using the actual impedance of one phase for both Z_1 and Z_3. The angle between the primary impressed and the resultant displaced electromotive forces will be 90 degrees ± the angle between the primary impressed and primary induced electromotive

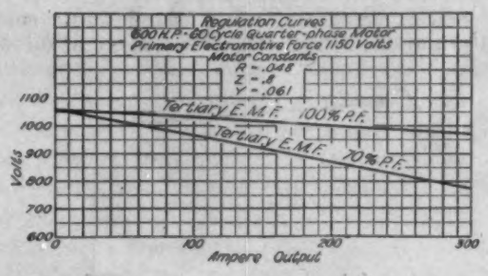


FIG. 8.

forces ± sin^{-1} (tertiary reactive drop divided by resultant terminal electromotive forces), the latter quantity being represented vectorially by a line from the center of the primary impressed electromotive force, or base line, to the apex of the electromotive force triangle. In the three phase electromotive force triangle the actual quadrature voltage plotted must be the calculated quadrature voltage multiplied by .866.

In the foregoing analysis the motor slip has been neglected, but its effect on the results is insignificant, as in any practical case it is very small. It acts to reduce the effective quadrature electromotive force in proportion to the cosine of the slip, expressed in electrical degrees; and even for a slip of one tenth, this would only reduce the voltage by about one per cent. The slip of a phase converter is not dependent directly on the power output, but upon the power factor as well, as the slip is proportional to the current in the rotor. Thus, for small outputs at low power factors, the slip may be as large as for high outputs at high power factors, since the copper loss in the rotor

may be as high in the first case as in the second.

The phase converter does not "fall out of step" as an induction motor does, when it passes beyond its point of maximum torque, but it has the same power characteristics as other induction machines, limiting it to a definite maximum output. However, when running from a single-phase system of large capacity, this limit to the output of the phase converter does not limit the input to the receiving system, as after the maximum output of the converter is exceeded, the apparatus running from it will merely draw more heavily upon the single-phase supply system, and continue running, although under conditions of greatly distorted impressed electromotive force.

The curve Figure 8 shows the results of the above calculations applied to a 600 horsepower, 1150-volt, quarter-phase motor, run as a phase converter, and gives a good idea of what can be expected from commercial induction motors used in this way. It will be seen that with the ma-

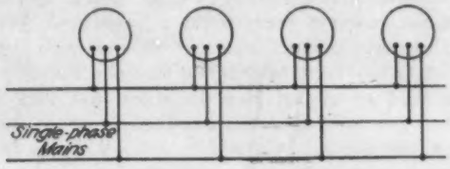


FIG. 9.

chine running light (no load on the polyphase system), the tertiary electromotive force is about 92 per cent of the primary, and that with 200 amperes output, representing about 400 kilowatts input to the polyphase receiving circuit, the tertiary voltage has fallen to about 87 per cent of the primary. With 200 amperes output at 70 per cent power factor, the regulation is, of course, somewhat worse, the tertiary voltage having fallen to about 78 per cent of the primary. The motor upon which these results were obtained was above the average in size, and on small machines such good results cannot be expected; in the case of a 50 horsepower motor operating as a phase converter, with the polyphase system drawing about the rated power of the motor, the tertiary electromotive force would be about 80 per cent of the primary electromotive force at unity power factor, and about 60 per cent of the primary electromotive force at 70 per cent power factor.

The practical uses of the induction phase converter are necessarily limited on account of this voltage distortion, and in fact, it is little more than an emergency machine. In case of an urgent demand for machinery to supply power to three-phase motors from single phase mains, it offers the cheapest and most easily available solution of the problem, and in case a permanent installation is desired, will serve the purpose very well while the requisite motor-generators are being manufactured.

In installations of several single phase motors it has also been proposed to eliminate the use of phase splitting devices for all motors except one, by starting this one with the usual resistance-reactance phase splitter, and then utilizing it as a phase converter for starting the rest of the motors as polyphase machines. One interesting and important feature of such a system has, however, been generally overlooked. If, after being started from the first motor, the others are left connected to it so that all are running in multiple from the single phase mains, and also have their third terminal connected, as in Fig. 9, both the continuous and maximum capacity of the motors will be materially increased, provided the motors are not all loaded at the same time. If part are heavily loaded and the rest running light or underloaded, the latter will supply power to the loaded machines, enabling them to run as polyphase instead of single phase motors. Such a connection allows the use of smaller motors than would be necessary for handling the load peaks if the straight single phase system were used.—General Electric Review.

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Steel City Electric Co., Pittsburg, Pa.

SWITCHES KNIFE.

G. E. Cat. No. 36846 and 42503. Double pole front connected switches, 15A. Cat. No. 36846, porcelain base, 125 volts, Cat. No. 42503, slate base, 250 volts. Approved Nov. 7, 1907. Manufactured by the

General Electric Co., Schenectady, N. Y.

RECEPTACLES FOR ATTACHMENT PLUGS.

M. & M. Flush Receptacle and Flush Plug, 10 A., 250 V. Approved October 21, 1907. Manufactured by

Machen & Mayer Electric Mfg. Co., Philadelphia, Pa.

PROTECTORS, TELEPHONE.

Porcelain block with line fuses and carbon lightning arresters, Cat. No. 258. Fuses are strips of fusible metal threaded through chambers in the porcelain. Approved Oct. 10, 1907. Manufactured by the

Sterling Electric Co., La Fayette, Ind.

SOCKETS, STANDARD.

Brass shell, key and keyless, Cat. Nos. 157, 0157, 357, 0357, 457, 0457, 557 and 0557, and "Snap Cap," Cat. Nos. 440-445 inclusive. Approved Nov. 14, 1907. Manufactured by

Pass & Seymour, Solway, N. Y.

WIRE, SLOW-BURNING.

Insulation consisting of three braids. See Rule 43, Nat'l Elec. Code (1907 edition). Approved Nov. 12, 1907. Manufactured by

American Electrical Works, Providence, R. I.
American Steel & Wire Co., Worcester, Mass.
Ansonia Electrical Co., Ansonia, Conn.
Alfred F. Moore, Philadelphia, Pa.
Philips Insulated Wire Co., Pawtucket, R. I.
John A. Roebling's Sons, Trenton, N. J.
Standard Underground Cable Co., Pittsburg, Pa.

THE ORDER OF REJUVENATED SONS OF JOVE.

To All Jovians:

At the annual meeting at Dallas, October 15th, after the fullest discussion as to the necessity of giving to the Order of the Rejuvenated Sons of Jove an ethical ideal and a serious purpose, a motion was made and unanimously carried, empowering the Reigning Fifth Jupiter, H. B. Kirkland, No. 285, to appoint a committee for the purpose of evolving, preparing and putting into effect a plan which would give to the Order the ideal suggested and would surround it with proper precautions for its secure perpetuation. In accordance with the authority invested in the present Jupiter by reason of this resolution, a committee was appointed which has already spent hours on this work.

For this reason and in order that the plans of the Committee as formulated may be put into effect, I, the Reigning Sixth Jupiter, have refrained from the appointment of Jovian Statesmen to represent me in the different districts until such time as the plans have more nearly reached perfection.

It is necessary that all of us be patient, believing that out of the earnest consideration that has been given our Order, a new era of greatness will be inaugurated.

Every precaution is being taken to prevent the possibility of the high officers of the Order using their position for selfish purposes. The effort is being made to guard against the weaknesses which have sapped the strength of all fraternal orders, and the aim of your committee is to make it absolutely impossible to keep a deserving Jovian from being elevated to the higher degrees, and to make it equally impossible for any Jovian, unfit for the honor, to be raised, no matter what influences may be brought to bear in his behalf.

No authority for Rejuvenations will be granted for the present, as it will take some little time for the completion of the plans of the committee, and our financial condition justifies us in getting everything in readiness before starting an aggressive campaign for increased membership.

The responsibilities placed on the committee and on the newly elected members of the Congress of Stars is tremendous, and out of respect for the earnestness of purpose with which they have approached the problem given them to solve, I ask that criticisms be withheld until after the complete plans have been put into effect.

Very truly yours,

W. E. ROBERTSON, No. 424,
The Sixth Jupiter.

Address of the Sixth Jupiter.

"Most Noble Jupiter and Fellow Jovians:

"In accepting the highest office within your gift, the dominant feeling which possesses me is one of deep responsibility—almost oppressive in its nature—rather than one of elation, at the honor of which I am the recipient at your hands.

"I heartily appreciate the honor conferred upon me, and during my term of office I will give to the administration of the office of Jupiter and the welfare of the Order my earnest and thoughtful attention and constant endeavor.

"At this time it seems appropriate that allusion be made to the efforts and deep interest taken in the welfare of the Rejuvenated Sons of Jove by its founders, many of whom had little conception of its possibilities, and only he, our First Jupiter, C. W. Hobson, No. 1, in whose inner consciousness the idea was conceived, and his coterie of immediate and devoted friends had the imagination to foresee and the faith to believe in its future greatness, holding fast to what they felt to be the germ of a great idea, they have piloted the Order in its early stages and found faithful successors to carry on the work up to the present time.

"The record of my immediate predecessor, the Fifth Jupiter, H. B. Kirkland, No. 285, has been second to none in the added impetus given the Order and the large number of new members added during his administration. His efforts have been nobly seconded by the present Mercury, C. B. Roulet, No. 213; the fidelity which he has shown in the care of the funds of the Order and the system inaugurated by him for the proper care of its records, deserve our highest commendation.

"In accepting the office, I have made no pledges of any kind to a living soul, and I wish to express my high appreciation of the delicacy and courtesy shown me by the Fifth Jupiter, H. B. Kirkland, No. 285, in not asking me to make a single pledge or promise in the interest of any individual or district, notwithstanding the fact that we were together for the nine days immediately preceding the Annual Meeting.

"In this Olympian city of Dallas, our Fifth Jupiter has called the Congress of Stars and all faithful Jovians together in order that we may take counsel with reference to the future welfare of our Order. The Ambrosia of which we partake is the spirit of good-fellowship which animates all who have become rejuvenated, and the Nectar is the milk of human kindness and charity which should and does flow through the veins of every loyal Rejuvenated Son of Jove.

"As a result of our deliberations and most careful consideration, it has been determined that the Rejuvenated Sons of Jove need an ethical ideal in order that they may have some common basis of understanding, in order that the co-operation and mutual help which they all desire to establish may have a permanent and solid foundation.

"In this the most enlightened commercial pursuit of the age, whose marvelous growth no man could foresee, and whose limitless future no living man would attempt to define, it seems appropriate that the ideal which we should adopt is that of simple honesty in our dealings with one another and the world at large.

"In considering the future fields for enlightened co-operation, it occurs to me that we are, in the light of actual experience, in a peculiarly strong position to point out the fallacy of Anti-Trust legislation, which has swept through the length and breadth of our fair land.

"While the Anti-Trust laws, at the time they were enacted, may have had sufficient reason for their existence, their actual operation has emphasized the fact that **competition on price alone is pernicious and detrimental to the best development of a high order of civilization.** Under these laws all wealth will be concentrated in the hands of a very few, or else the energies of our people will be turned to the production of the cheapest fabrics possible, ignoring the two vital elements which are inseparably connected with the best welfare of the people—**quality and service.**

"In the light of past experience, we should emphasize the fact that quality and service are of equal importance with price. That the standardization of price by commission or otherwise on a reasonably profitable basis, with the opportunity for unlimited competition in quality and service, giving as it will the opportunity for the highest development of the genius of our people in the production of articles of the highest artistic and durable character, combined with the widest distribution, is of far greater value to the nation as a whole, from an economic as well as altruistic standpoint, and more in keeping with the Twentieth Century ideas, than would be the inevitable sacrifice of these high essentials, if competition on price alone is to continue to be the dominant note in our industrial organization.

"In a peculiar sense are we fitted to carry on the work of enlightenment along progressive lines, on account of the fact that our industry touches human activity at every point, and that included in our membership, as loyal Jovians working together for a common end, the savant, the manufacturer, the distributor, and the consumer are enrolled, and that which affects the interest of one class must necessarily affect the interest of all others. Yet, notwithstanding this obvious fact, we have found a basis of co-operation common to all—therefore, I say, the duty clearly devolves upon us to spread the gospel of wise co-operation rather than of destructive competition through the farthest confines of our fair land."

CURRENT COMMENT

It is proposed to build reservoirs in Bridal Veil and Yosemite Creeks, Yosemite Valley, above the falls, in order to conserve the water so that it will flow three months longer, as the falls often go dry in August.

Through the successful work of the Vienna Academy of Science three grams of pure radium have been obtained from ten tons of pitchblende from Joachimsthal, Bohemia. It is worth $36,000 a gram, the laboratory work alone costing $9000.

Severe burns and partial blindness have been caused by exposure to powerful electric arcs or to the light from the mercury vapor lamp enclosed in quartz glass. This is entirely analogous to sunburn and should have the same treatment.

A loop of seven-strand aluminum telephone wire was strung 150 miles from Sacramento to Reno eight years ago, according to a correspondent of the Pacific Telephone Magazine. While conversation was marvelously clear, the practice had to be discontinued in the snow limit as the cumbersome splice gathered so much snow that the weight twisted off the wire.

The ratio of the electro-magnetic to the electrostatic unit of electricity has been recently determined at the National Bureau of Standards at Washington to be 2.9971×10^{10} which is within one-twentieth of one per cent of its theoretical value which should agree with the velocity of light. This value is required in many electrical measurements and calculations.

It has been estimated that every person in the United States uses, annually, about seven dollars' worth of electricity in some form. Trolley rides lead at $3 per capita; electric light is second with $1.50 per capita. Every man, woman and child buys $1.25 worth of electric apparatus and supplies, uses 75 cents' worth of telephone service, and 50 cents' worth of telegrams and alarms.

Because of the increasing manufacture of water gas and the greater use of incandescent gas lamps the protometer is being replaced by the calorimeter in many gas works where the heating value is more important than the candle power. A calorimeter recently placed on the English market gives a direct reading of the calorific value of the gas on a scale of every two degrees between 400 and 800° B. T. U.

Concrete may be mixed and placed during freezing weather with safety provided certain conditions obtain or certain precautions are taken.

The concrete aggregate may be heated, or hot water or steam may be used in the mixing. This hastens the set. Sodium chloride, calcium chloride or other chemicals may be added, so as to lower the freezing point of the water. The work may be enclosed and the interior of the enclosure maintained above a freezing temperature until the concrete sets naturally.

The German chemist, Dr. Theodore Grosse, is said to have succeeded in breaking up the element platinum by subjecting potassium carbonate, maintained at a high temperature in a platinum vessel, to the action of an alternating current between platinum electrodes. After some time, the electrodes became coated with a deposit of charcoal-colored crystals, and gave evidence of having been attacked, both the electrodes and the containing vessel losing weight. On extracting the melt, a brown powder free from carbon or potassium was obtained. Although both the crystals and the powder gave solutions from which they were precipitated by hydrogen sulphide, the presence of platinum could not be detected.

The United States Civil Service Commission announces an examination on January 8, 9, 10, 1908, to secure eligibles from which to make certification to fill two vacancies in the position of mechanical and electrical draftsmen, one at $1,200, and the other at $1,500 per annum, in the office of the Chief of Ordnance, War Department, and vacancies requiring similar qualifications as they may occur in any branch of the service. The examination will consist of mathematics, calculations, materials, electricity, drafting, training and experience (rated on application). Examinations will also be held for the positions of first class steam engineer at $1,200 per year for the Custodian Service, and for civil engineer and superintendent of construction at $1,500 per year, in the Quartermaster's Department at large.

The Lackawanna line and other big systems have decided to do away with switchmen in the freight terminals of their lines, and in their stead will install towers, in which electric buttons releasing compressed air will do the work formerly done by switchmen. In the Hoboken yards of the Lackawanna, which consists of twenty miles of track, controlled by 131 switches, the old style switchman has been wholly done away with, and consequently death and accident by the switching of cars has been almost entirely eliminated. Other large systems are preparing to install the new yard system of switching. By the new system once a track is opened it is automatically and electrically locked, so that until the completion of that particular switching operation it is impossible to change the route or to throw another switch. The automatic switch does not get confused or lose its head in a crisis, and it does not visit neighboring saloons.

Selenium is almost a non-conductor of electricity in the dark, while under the influence of light its conductivity immediately becomes greatly increased. This characteristic has led to its use in instruments designed for lighting and extinguishing gas buoys automatically; for guiding and exploding torpedoes by a ray of light; for telephoning along a ray of light; for transmitting sounds and photographs or other pictures to a distance by means of a telephone or telegraph wire, and for measuring the quantity of Roentgen rays in therapeutic applications. A general or practical use of any of these instruments would result in an increased demand for selenium. At present the metal is variously quoted at from $6 per pound to $2 per ounce, as there is no steady market and the prices vary with different dealers. No selenium is known to be produced commercially in this country, but during 1906 one copper refinery made some in an experimental way. At this refinery the selenium was obtained from the anode slimes or mud, where it is left with gold, silver and other residues in the electrolytic refining of copper. Minerals containing selenium are of rare occurrence in the United States, but a demand for the metal could probably be supplied by utilizing the small quantities found in the copper refinery slimes. It often occurs with sulphur and tellurium, being similar to them.

The JOURNAL of ELECTRICITY POWER AND GAS

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Entered as "The Electrical Journal," July, 1895.
Entry changed to "The Journal of Electricity," September, 1895.

VOL. XIX DECEMBER 14, 1907 No. 24

EDITORIAL.

Electric Interests Little Affected By Financial Storm

By this time it is recognized that we are in the midst of a financial depression occasioned largely by lack of confidence of the investing public. The obvious remedy is the speedy restoration of this confidence by the elimination of the causes leading to it. Some smart man once said that the only lamp that guided his feet was the lamp of experience. Yet experience, like the stern lights of a vessel, illuminates only the paths over which we have passed. Observation shows that business not only moves, but changes as well, and that everything in business has changed excepting business principles. The extent to which one realizes this is often the measure in which he succeeds.

Noting the changes in financial conditions since the debacle began last January, it is to be observed that the great electrical interests of the country have fared better than cognate projects of magnitude, and that the future is bright with promise. True, the shrinkage in values has been enormous, and the cessation of progress in some cases disastrous to the wonted financial strength of many great corporations, but only temporarily, and a survey of the electrical field gives ground for the belief, born not of hope, but of reason, that in the present financial flurry the world-wide demand for electric power and its applications precludes possibility of any permanent set-back.

Inquiry into the cause of the scare and lack of confidence is as natural as into the compelling influence of any occurrence, be it an earthquake or a bank failure. The reasons assigned are numerous: Roosevelt, Wall Street, bank frauds, undigested securities, sunspots, business congestion, and sundry other causes being assigned for the storm that so lately overwhelmed us. The forcible fulminations of our impulsive, but well-meaning, chief executive, were no more the cause than is the lightning flash the cause of the rain-storm. Each has precipitated the effect under certain propitious conditions. These conditions are founded upon the growing conviction that the prices paid for the things we have been buying were entirely too high for their actual intrinsic value. If not bought for their immediate and necessary use, it was in the vain hope that they would go still higher in their meteoric course. Many trust and investment companies are heavily freighted with securities that have depreciated because they were never worth what was paid for them, the purchasers having erred in judgment. Law-breaking corporations were able to pay attractive dividends, even on an inflated stock. National and State investigations of these nefarious methods have precipitated a rain of laws, and a consequent wave of distrust that has overwhelmed both the just and unjust. The banks came to the breach and formed an artificial barrier until the danger likewise threatened them, and their support was removed—further credit was denied.

For the past four years signs were not wanting that many business wires were short circuited, and that many business plants were carrying loads for which they were not originally designed. The danger signals were disregarded with a recklessness that is always magnificent in case of success, but reprehensible in the face of failure.

But, fortunately, though the high-tension current has destroyed where proper precautions have not been taken, yet the fundamental structure is intact, and after the necessary repairs have been made, is ready to resume work on a basis safer and saner than before. The ready repair of Congressional currency tinkering will have no more lasting effect than a draught of brandy on the bodily frame. But, as bullion is the blood of business, so real, lasting recuperation can only be obtained by building upon a firm foundation. We advance nobly and rapidly in many business lines, but, like a well-seasoned aphorism that continues to be quoted because it cannot be improved, we need, occasionally, to hark back to the elementary principles of business success, which, though terse and trite in these times, take on the attributes of eternal truth. Timidity is to be decried, but a sane conservatism is ever essential in all enterprises, great or small.

Currency reform, or guarantee of safety of deposits in national banks, are stimulants that but postpone the inevitable collapse, by treating the body for the effect, rather than the cause, of the disease. Would not much of our present distress have been avoided if there was a national statute that nobody in any way connected with a bank or trust company as officer or director, should ever legally borrow the bank's money

upon any form of security? It would at least supply the needed safeguard and prop to the banking situation.

Evidently, the present stagnation and relaxed production, which will be brief because of our country's strength, is but the quiet preceding an era of continued and greater growth. And particularly is this true in the case of the electrical interests, in this west half of America, which depend largely upon the utilization of our great water resources; for they offer such wondrous possibilities, not only in economic production, but also in varied application that the capital of renewed confidence will soon be flowing to their advancement. Investors interested in good securities, calamity howlers condemned, and political intriguers ostracized, will maintain this confidence. Already from every quarter comes report of renewal of work and resumption of development. Ranking as a national necessity, the electrical industries, which last and lightest felt the pinch, will soon look back on the sudden flurry as those on a quieting sea view the squall vanishing upon the horizon.

PERSONALS.

Alex. Henderson (How!), representing the American Circular Loom Company, is in San Francisco.

Milton K. Akers is instructor in electrical engineering at the Washington Agricultural College, Pullman, Wash.

Dow S. Smith, formerly general superintendent of the Brooklyn Rapid Transit Company, is at Spokane, Wash.

Albert J. Dibblee, attorney-at-law, announces the removal of his offices to the Union Trust Building, San Francisco.

Louis E. Reynolds, formerly with the California Gas & Electric Corporation, is now in the construction department of the Central Colorado Power Company at Colorado Springs, Colo.

W. Anderson, formerly engineer and manager of the Cascade Water Power & Light Company, is now at Rossland, B. C., as engineer for the West Kootenay Power & Light Company.

Dr. Lee De Forest explains that the fundamental difference between wireless telegraphy and wireless telephony is that in the former waves of steadily decreasing amplitude are used, being obtained from a spark discharge for periods corresponding to the signals of the Morse code, while in telephony the waves are of constant frequency steadily maintained, the amplitude being varied to correspond to the frequency of the voice tones.

"THIS REMINDS ME"

Mr. John Gordon Cole

Representing John R. Cole Co

Arrived in S. F. Monday night at 8:30. Weight 9 lbs.

E. M. Scribner

TRADE CATALOGUES.

"A Modern Telephone Plant" is the title of a neatly designed and well worded booklet from the Dean Electric Company, of Elyria, Ohio, manufacturers of telephone apparatus.

Catalogue No. 21 from the Chicago Fuse Wire & Manufacturing Company of Chicago, Ill., covers their line of "Union" switch boxes in a thorough manner that will interest all electrical contractors.

Cook's Standard Tool Company of Kalamazoo, Mich., sends a booklet of information to track men on Labor Saving Track Appliances, including track drills, track tool grinders, car jacks, track jacks. cattle guards, etc.

H. W. Johns-Manville Co. send a number of interesting circulars illustrating and pricing various articles, including Noark fuse plugs, J.-M. asbestos lead joint runner, J.M. insulated arc lamp hanger and asbestos papers, roll board, sheet board, building felts, etc.

Stephen T. Williams & Staff, 346 Broadway, New York City, send an amusing souvenir called "Dollar Blinders," a pair of spectacles whose glasses are covered with pennies, "for those who are inclined to hold pennies so close to their eyes as to entirely lose sight of dollars."

"The Electric Locomotive in Heavy Passenger and Freight Work," is the title of Bulletin No. 4537, recently issued by the General Electric Company, Schenectady, N. Y., in which is described a large number of present and proposed representative types of electric locomotives, ranging from 17 to 150 tons for all classes of service. Electrical and mechanical data are given and characteristic curves for each locomotive shown.

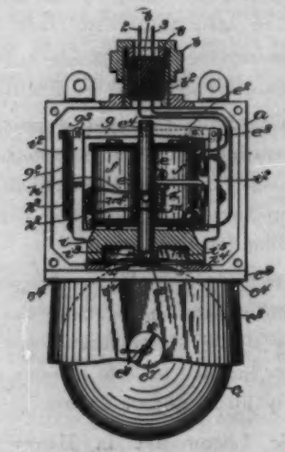
In Bulletin No. 4546 the General Electric Company, Schenectady, N. Y., has issued a handsomely bound pamphlet of 24 pages in which the electrification of the West Shore Railroad between Utica and Syracuse has been very completely described. Special attention has been attracted to it on account of its 60,000-volt transmission line, the adoption of an inverted, protected third rail, and the hydro-electric development from which power is supplied.

The Bristol Company of Waterbury, Conn., are issuing three new bulletins covering their electrical instruments: Bulletin No. 61, describing recording voltmeters, which is in twelve pages, illustrated, and is very complete; bulletin No. 62, describing recording ammeters, lists new form of portable instrument, which is now being manufactured and is very attractive in its make-up. Bulletin No. 63 covers a line of recording wattmeters and is somewhat larger than the others, having nineteen pages. This bulletin, besides illustrating the new portable type of wattmeter, also shows a very complete list of single, two-phase and balanced three-phase alternating current instruments, something that was absent from former bulletins. These catalogues will be appreciated by engineers who are usually in a quandry as to the best type of instrument applicable to the loads for which they intend to design, and will be found very helpful in locating the proper instrument manufactured.

PATENTS

ELECTRIC BELL. 871,168. Henry J. Heeney, Boston, Mass., assignor to Holtzer Cabot Electric Company.

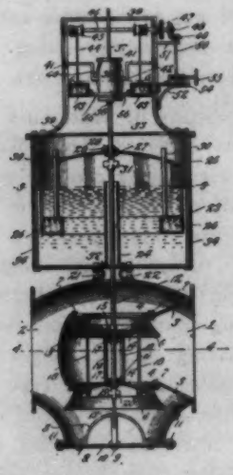
In an electric bell, the combination with an electro-magnet; an armature, and a striker operated thereby; of an inclosed casing for electro-magnet, armature and striker; a gong sup-



ported outside of the casing in the field of impact of striker; a diaphragm forming a part of the wall of casing, and being interposed between striker and gong; and means for preventing diaphragm from vibrating.

GAS-PRESSURE REGULATOR. 872,273. Adelard D. Brasson, San Francisco, Cal. Filed July 9, 1907. Serial No. 382,952.

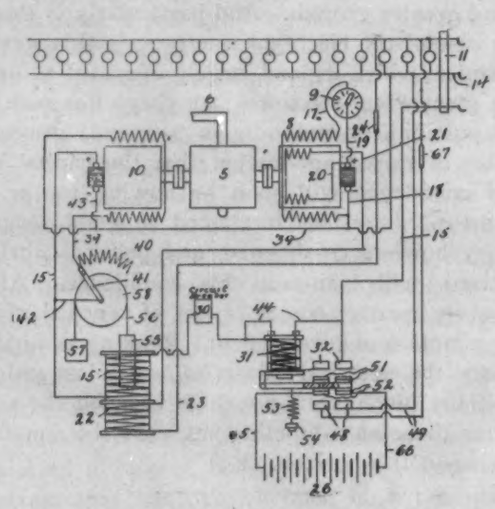
A gas pressure regulator comprising an inlet section provided with flaring valve seats, oppositely disposed valves connected to a hollow shaft, a gasometer, a gasometer bell



secured to shaft, and a rotatable governor supported upon the upper end of hollow shaft and provided with oppositely disposed spiral ribs, guides provided with lugs to bear against ribs, and an annular mercury chamber provided with flexible pipes leading therefrom to the rotatable governor, and means for raising and lowering the mercury chamber.

ELECTRIC TRAIN-LIGHTING SYSTEM. 871,826. Walter Scribner, Columbus, Ohio. Serial No. 351,924.

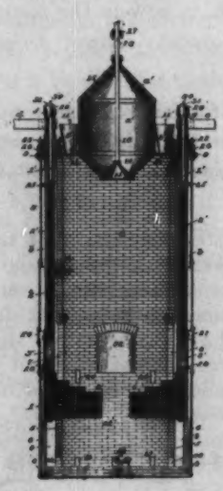
In a train-lighting system, the combination with a plurality of cars, of a set of storage batteries carried upon each of the cars, a main lamp circuit which extends through the cars, a battery charging dynamo, and automatic switches



adapted to connect the storage batteries of each car in parallel on to the main lamp circuit of cars and also adapted to automatically and simultaneously connect the battery charging dynamo in series with the storage batteries and disconnect batteries from the lamp circuit.

ELECTRIC FURNACE. 871,971. Edward R. Taylor, Penn Yan, N. Y. Filed Sept. 5, 1906. Serial No. 333,368. Renewed April 15, 1907. Serial No. 368,248.

A resistance electric furnace having, in combination, a wall of fire brick inclosing a central working chamber, an outer shell surrounding wall and inclosing an annular feed space between wall and shell, means for supplying feed space with self-moving material for treatment, connections with



a suitable generator of electricity, metallic electrode stems to which connections are attached and which extend downwardly therefrom within feed space, and a pair of carbon electrodes attached to the lower ends of stems, located wholly within shell, and supported beneath by bolster forming portions of wall within embrasures through which the respective electrodes extend into the working chamber and toward each other.

INDUSTRIAL

MODERN A. C. WATTMETER TESTING.

By J. E. Bridges and H. W. Young.

Until within a comparatively recent period, the testing of central station wattmeters has been a rather difficult matter, principally due to the fact that no first-class facilities were available, and what were available proved to be more or less expensive and unsatisfactory. This condition was due to one or a combination of several causes which may be outlined as follows:

FIG. 1. PRECISION WATTMETER MOUNTED IN CASE

First, the methods used required several instruments; second, two men were frequently required to test service meters on the customers' premises; third, service meters were usually disconnected, taken to the testing room or laboratory to be calibrated and then returned to the customer.

The relative merits of the methods employed may well be considered and compared. In the first case it was originally necessary to employ a voltmeter, an ammeter and a stop watch, the method also requiring a considerable amount of calculating besides using for portable or rough usage, instruments which the average station used for their primary or absolute standards. When the indicating wattmeter became available it permitted the station men to take better care of their voltmeters and ammeters as well as making a lighter load for the meter man to carry, but this still had the disadvantage of requiring calculations, and allowed of only average wattmeter readings on more or less unsteady voltage.

In the second case it was frequently very annoying to the majority of customers to have two men call for the purpose of testing the meter, as the average consumer is invariably skeptical regarding the meter, and a visitation of two men with the large amount of paraphernalia convinced him that something was radically wrong. In residences it was often difficult for two men to gain admittance, unless they were known, and, as a rule, the expense of two men did not warrant the use of their services considering the number of meters tested. Especially was this true in the testing of induction meters, the inaccuracy of which is seldom very great.

The third method is now very seldom found in practice, except in the testing of direct current meters. It never had many points in its favor, but on the contrary, had numerous ones against it, among the more important being a double annoyance to the customer, even in some cases to the disconnecting of his service. Very often a meter's calibration would not check within a large percentage after being removed and carried, as it would if its position had not been altered. Much time was lost by this method, and as the meter might have been tested in the station on non-inductive load, whereas its operating load would possibly have been very inductive, making possible in some meters an error of considerable magnitude.

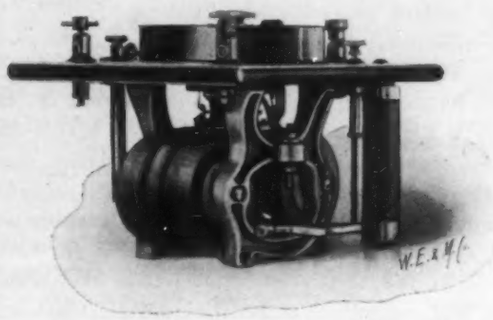


FIG. 2. INTERNAL CONSTRUCTION OF PRECISION WATTMETER

There were several methods used to place loads on the meters being tested. It was often considered best to employ the connected load by turning on lamps, motors, etc. About the only points in favor of this method were to find out if all the customer's connected load registered on his meter, and it also saved the meter tester from carrying a load. On the other hand, it invariably caused suspicion on the customer's part that the company was trying to increase his bill, and he would declare this to be the case, especially if his bill were a trifle higher than usual the next month, due to the meter's running slow previous to calibration. The method consumed too much time and unnecessary traveling about the customer's premises. However, this method is still feasible, even today, in exceptional cases such as on heavy motor loads where the service could not be interfered with in any way.

Within the past two or three years a number of different types of testing meters have been developed and the prospective purchaser has a varied assortment to choose from. Two sets of standards should be employed, one being used as a "primary" or testing-room standard, and

the other as a "secondary" or portable standard for testing on the consumer's premises.

In deciding upon the type of primary standard to be used, permanent accuracy should be the first consideration, as these instruments must be depended upon over long periods without recalibration, as it is obvious that any change in the accuracy of the primary standards will in turn affect the secondary standards, and through these the entire meter system will in time be rendered inaccurate. This permanency in primary standards used at considerable distances from the manufacturer or standardizing laboratories is especially important as a meter inherently fallible would prove a constant source of trouble and expense.

The electrical design of the primary standard should be such that the calibration will not be affected by stray magnetic fields, variations in frequency and wave form; should have a low temperature co-efficient and preferably be provided with a high-grade thermometer in order that absolute temperature corrections may be noted and applied to the readings.

If possible, the primary standard should be suitable for use on A. C. or D. C. circuits, thus permitting the use of one type of "Universal" standard instead of maintaining a separate standard for each class of service.

The mechanical design should be such that the standard could readily be shipped by express without danger of impairing its accuracy, for if it lacks this feature the danger always exists that the average user, not having proper means for standardizing, will permit the primary standard to remain unchecked for too long periods. In order to secure a reliable and permanent device the bearings or suspension must be so designed that whatever friction may initially exist will remain constant over a long period of service. The controlling or restraining force must be permanent in character, thus preventing any change in calibration, due to changes in the initial value.

The "Siemens" laboratory dynamometer meets many of the essentials of a primary standard, but owing to its construction can not readily be made "astatic," and is, therefore, more or less subject to the effect of stray magnetic fields. Owing to its necessarily delicate suspension, this type of meter is not at all portable and to secure the best results must be calibrated at the place and position in which it is to be used—a condition frequently impossible to meet, especially for stations not fully equipped for standardizing work.

The Kelvin laboratory balances, being of the "astatic" type, more nearly meet the imposed conditions, but the usual construction is such that they can only be used as bench or fixed standards. It is also quite difficult to transport the Kelvin balances to and from a standardizing laboratory owing to their size and construction. They have, however, long been justly recognized as absolute and reliable A. C. and D. C. primary standards, both in this country and abroad.

The essentials of a commercial primary A. C. and D. C. standard outlined in the foregoing are fully met by the Precision type of voltmeters, ammeters and wattmeters shown in the accompanying illustrations and will be found to be a most useful and practical equipment for the testing room of central stations.

Fig. 1 illustrates a Precision wattmeter mounted in its case, the ammeters and voltmeters being similar in appearance. The internal construction is shown in Fig. 2, the measuring elements consisting of a set of four stationary coils, which in voltmeters are wound with fine wire and in ammeters and wattmeters with heavy wire, depending in size upon the current to be carried. The moving coils (two in number) are mounted on a light aluminum framework and mounted on a shaft, the lower end of which carries a sapphire jewel. In a removable screw secured to the mounting frame is located a second sapphire jewel and between them is located a polished steel ball approximately one-sixteenth inch in diameter. This arrangement insures a lower bearing in which the friction is not only negligible, but one which is permanent and not easily damaged or thrown out of adjustment. The upper bearing consists of a small polished steel pin located at the top of the shaft and centered in a small guide bearing.

The Precision meters, being of the Kelvin type, depend for their operation upon the electro-magnetic action between the fixed and movable coils. The coils are so connected that with current flowing the movable pointer is deflected to the left of zero, and in order to bring it back to zero it is necessary to turn the knurled nut or torsional head controlling the restraining springs and indicating pointer until the movable system is brought back to zero. The position of the indicating pointer thus indicates a position of equilibrium between actuating and restraining forces and in conjunction with the scale affords a ready means of measuring the current or potential values.

The meters are absolutely independent of stray field effect, owing to the astatic arrangement of the measuring system. They may, therefore, be used in proximity to cables carrying current or on D. C. circuits without the necessity of taking reversed readings.

In the lower capacity ammeters, not exceeding five amperes, the coils can be arranged for series parallel connection, and this has been taken advantage of in one capacity having a range of .5-1 amperes and another having a range of 2.5-5 amperes.

Wattmeters are also provided with double-current capacities in the lower ranges, and in the larger sizes are provided with three-current capacities of 5, 20, 100 amperes, these being secured by winding the fixed current coils in three sections, each of different capacity and connected in series. Taps are brought out from each section and connected to separate binding posts, the open end of the heaviest coil being secured by winding the fixed current coils in three sections, each of different capacity and connected in series. Taps are brought out from each section and connected to separate binding posts, the open end of the heaviest coil being connected to a common post.

Voltmeters and wattmeters require the use of an external resistance box to be used in series with the potential circuit. By means of these resistance boxes a range of voltage from 100 to 2000 volts can be measured. The resistances are composed of special alloys not subject to variation or deterioration and mounted in ventilated cages.

The problem of keeping central station meters in check with the standards of a reliable standardizing laboratory has been very difficult to managers, especially those of the smaller stations, as the cost of such standardization will in a few years' time amount to a very considerable expense. In the Precision standards illustrated above this feature has been taken care of by a feature which permits the purchaser

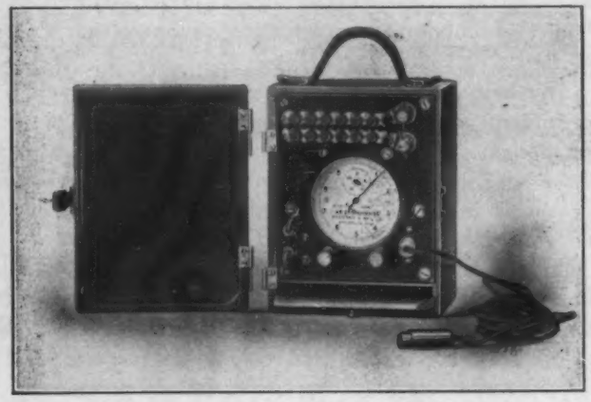


FIG. 3. INTEGRATING METER

to return the meter to the laboratory and have it rechecked free of cost for a period of five years. By this method the central station manager has access to a laboratory which could not be built up or maintained outside of a highly organized company.

The secondary standard may consist of a Portable indicating wattmeter used in conjunction with a stop watch and testing formula, or may consist of a portable standard integrating wattmeter. The latter method is to be preferred for practical work, as it eliminates the stop watch with its attendant errors, the accuracy of the test does not depend upon the maintaining of a constant load, and the work can be accomplished at less expense.

Fig. 3 illustrates one of the latest developments in this type of meter and consists of a high-grade integrating meter provided with measuring coils of 5, 10, 20, 40 amperes and potential coils of 100-200 volts. A specially designed registering mechanism is provided having a fast moving pointer corresponding in speed to that of the disk of the meter under test and a counting dial for totaling the revolutions. To test a service meter by the standard integrating watt-

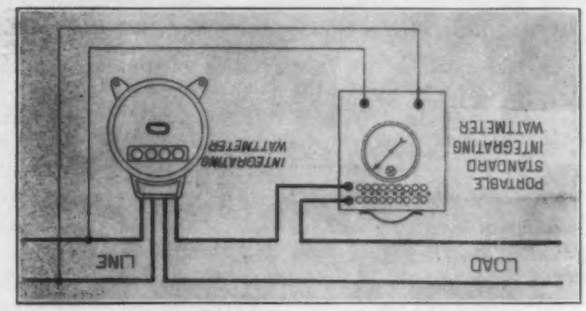


FIG. 4. CONNECTION FOR INTEGRATING METER

meter method, the meters should be connected as shown in Fig. 4, and the connection plugs of the standard so arranged that its capacity will be the same, or approximately the same, as that of the meter under test. The proper connections having been made, the load should be adjusted to the desired value and a direct comparison made of the number of revolutions of the meter under test with the number of revolutions shown on the counter of the standard. In common with the indicating standard method, readings should be taken for at least one minute to eliminate personal errors. The percentage of error in the meter under test may be

CALIBRATION DATA FOR WESTINGHOUSE STANDARD PORTABLE INTEGRATING WATTMETERS

Make	Service Meter Amperes Capacity	Service Meter Revolutions Heavy Load	Service Meter Revolutions Light Load	Standard Meter Ampere Capacity	94 Per Cent	95 Per Cent	96 Per Cent	97 Per Cent	98 Per Cent	99 Per Cent	100 Per Cent	101 Per Cent	102 Per Cent	103 Per Cent	104 Per Cent	105 Per Cent	106 Per Cent
*Westinghouse Types B and C	5	25	...	5													
	10	25	...	10													
	20	25	...	20	26.5	26.25	26.00	25.75	25.5	25.25	25.	24.75	24.50	24.25	24.00	23.75	23.50
	40	25	...	40													
	5	..	1.0	5													
	10	..	1.0	10													
	20	..	1.0	20	1.06	1.05	1.04	1.03	1.02	1.01	1.	.99	.98	.97	.96	.95	.94
	40	..	1.0	40													
	80	15	...	40	31.8	31.5	31.2	30.9	30.6	30.3	30.	29.7	29.4	29.1	28.8	28.5	28.2
	80	..	1.0	40	2.12	2.1	2.08	2.06	2.04	2.02	2.	1.98	1.96	1.94	1.92	1.90	1.88
	3	30	...	5	19.05	18.90	18.72	18.54	18.36	18.18	18.	17.82	17.64	17.46	17.28	17.10	16.92
	3	..	2.0	5	1.27	1.26	1.25	1.23	1.22	1.21	1.2	1.19	1.18	1.16	1.15	1.14	1.13
General Electric Type I	5	30	...	5	28.62	28.35	28.08	27.81	27.54	27.27	27.	26.73	26.46	26.19	25.92	25.65	25.38
	10	30	...	10													
	5	..	2.0	5													
	10	..	2.0	10	1.91	1.89	1.87	1.85	1.84	1.81	1.8	1.78	1.76	1.75	1.73	1.71	1.69
	15	30	...	20	23.85	23.62	23.4	23.17	22.95	22.72	22.5	22.05	21.83	21.6	21.38	21.15	20.93
	15	..	2.0	20	1.59	1.57	1.56	1.54	1.53	1.51	1.5	1.48	1.47	1.45	1.44	1.42	1.41
	25	30	...	20	35.72	35.38	35.05	34.71	34.37	34.04	33.7	33.36	33.03	32.69	32.35	32.02	31.68
	50	30	...	40													
	25	..	2.0	20	2.38	2.36	2.34	2.32	2.29	2.27	2.25	2.23	2.2	2.18	2.15	2.13	2.11
	50	..	2.0	40													
	5	30	...	5													
	10	30	...	10	23.85	23.62	23.4	23.17	22.95	22.72	22.5	22.27	22.05	21.82	21.6	21.37	21.15
	40	30	...	40													
	5	..	2.0	5													
	10	..	2.0	10	1.59	1.57	1.56	1.54	1.53	1.51	1.5	1.48	1.47	1.45	1.44	1.42	1.41
Fort Wayne Type K	40	..	2.0	40													
	25	30	...	20	23.85	23.62	23.4	23.17	22.95	22.72	22.5	22.27	22.05	21.82	21.6	21.37	21.15
	50	30	...	40													
	25	..	2.0	20	1.59	1.57	1.56	1.54	1.53	1.51	1.5	1.48	1.47	1.45	1.44	1.42	1.41
	50	.	2.0	40													

It is recommended that test be made at approximately 100 per cent and 4 per cent of full load if these loads are within the range of standard meter.

Load service meter so as to give revolutions stated in table in approximately one minute time.
Where possible, the capacity of coils used should be the same for both service and standard meters.
*Westinghouse Round Pattern and type "A" meters make fifty revolutions per minute at full load.

found directly by dividing the number of revolutions of the standard; that is, if the meter under test makes ten revolutions while the standard meter shows 10.4 revolutions, the ratio would be .96, showing the meter under test to be 4% slow.

The above method applies only when the meter under test has the same full load speed as the standard, namely, 25 revolutions per minute. When testing meters which run at different full load speeds than the standard or at different speeds for different capacities, it will be necessary to use a multiplier, this multiplier depending upon the ratio of the normal speed of the meter under test to that of the standard.

If it is desired to test a three-wire meter by means of a rotating standard under running load, the standard should be connected into the circuit in such a manner as to place the standard in circuit with one side of the meter, the other side of the circuit being left open. When the meter is tested under these conditions, the pointer of the rotating standard will rotate twice as fast as the disk of the meter under test which has but one-half of its current winding in use during the test. To effect a direct comparison, the number of revolutions of the meter under test should be multiplied by two. In order to make the standard integrating wattmeter method of test applicable to meters of different manufacture, the table given below has been compiled by working out the multiplying constant applying to each type.

In explanation of the use of this table the following examples are given:

1st. If it is desired to test a Westinghouse service meter by using the rotating standard, the two meters should be connected in series and loaded so as to give one revolution of the disk in approximately one minute's time for a light load test, and for full load 25 revolutions of the disk in the same time. The number of revolutions made for these two loads by the standard—if the service meter is correct—would be 1 to 25 respectively. If the number of revolutions made by the standard is 1.03 the service meter is 3% slow at light load. If the number of revolutions of the standard is .97 the service meter is 3% fast at light load. From this example it will be seen that the accuracy can be determined for any speed within 3% fast or slow, reading same directly from the table without any calculation whatever.

2d. If it is desired to test a 5-ampere General Electric meter, the load can be adjusted to give, say, two revolutions at light load and thirty revolutions of the disk at heavy load. If the meter is correct the standard will show 1.8 and 27 revolutions respectively. If the standard shows 1.85, the service meter is 3% slow at light load. If the standard shows 1.75, the service meter is 3% fast at light load.

3d. If it is desired to test a 5-ampere Ft. Wayne meter the load can be adjusted to the same value as with the General Electric meter. If the meter is correct, the standard will show 1.5 and 22.5 revolutions respectively. If the standard shows 1.54, the service meter is 3% slow at light load. If the standard shows 1.45, the service meter is 3% fast at light load.

NEW TURBINE AT CENTERVILLE PLANT.

The Allis-Chalmers Company, Milwaukee, Wis., have just put into commercial operation a 9,700-horsepower Francis turbine at the Centerville plant of the Valley Counties Power Company, owned by the California Gas and Electric Corporation, of San Francisco.

The success deserves a remarkable place in the history of hydraulic turbine engineering, as never before has a Francis wheel been designed for the extremely high head of 550 feet.

We know from reliable source that this power unit is a magnificent piece of work, not only on account of the perfect design, the pleasing appearance due to the harmony of the lines, and the extremely smooth running, but also on account of the high efficiency proven from tests made by the owner.

It may also be noted that a governor operated relief valve connected is working perfectly, discharging the 190 cubic feet per second suddenly turned off from the turbine by the governor, without exceeding a pressure rise of 7½ per cent above the normal pressure in the pipe line.

We are also glad to say that a description of the hydraulic output is secured for our journal.

Our congratulations of the success to the consulting engineer, Mr. F. G. Baum, of this city, who proposed the installation of a Francis turbine, as well as to the successful designer, Mr. A. Pfau, consulting engineer of the manufacturing concern.

Westinghouse storage batteries for portable use are pictured and listed in a sumptuous booklet from the Westinghouse Machine Co., who, while they have been in the storage battery business for several years, have heretofore issued literature only on the stationary types. This is their initial publication devoted exclusively to storage batteries for portable uses.

Poles form the subject matter of a handsomely illustrated brochure from the Western Electric Co. It is pictorially devoted to an exposition of the peculiar excellence of this company's poles, piling and ties, as the result of their careful choice and rapid handling of material.

J. N. Kelman, 1000 N. Main Street, Los Angeles, Cal., sends an interesting folder illustrating and describing Kelman high voltage switches and circuit breakers for 15,000 to 100,000 volts.

Bellingham, Wash.—For the purpose of furnishing additional power for the electric light system in South Bellingham and also power for the new flour mill, the Whatcom County Railway & Light Company is preparing to build a small sub-station near the gas plant. The building will be of brick and dynamos will be installed to generate power for the south end of the city. The flour mill, which will be placed in operation within the next two months will require about 150 horsepower. All of the machinery will be run by electric power. By the building of the sub-station the electric lights in that end of the city will be materially improved.

NEWS NOTES

TRANSMISSION.

Prescott, Ariz.—The management of the Shylock mine has under consideration a number of bids for steam and electrical machinery to be purchased and installed. C. E. Meyer of Glass & Meyer of Pittsburg, Pa., has arrived to inspect the property.

Alamogordo, N. M.—M. H. Fisher, owner of the Alamogordo electric light plant, is completing arrangements with D. Burney who has a ranch one mile west of Alamogordo, to make a test of the capacity of a bored well. The plan includes sinking an 8-inch cased well to the principal water-bearing strata. A high-tension transmission line will be extended from the electric light plant to the Burney ranch, a 25-horsepower motor will be belt connected to a high-speed centrifugal pump, and this connected to the well. When Mr. Fisher's hydro-electric plant in the Fresnal Canyon is completed, it will give him 2200 horsepower to dispose of for pumping and general power purposes.

Lakeport, Cal.—The Lupoyoma Development Company has acquired a controlling interest in the Kelseyville National Gas Company and in the Lake County Electric Power Company. It has thus obtained the franchises and rights held by one company in Lakeport and the source of power supply owned by the other in the gas wells at Kelseyville. Orders have already been placed for part of the machinery and poles. B. H. Henderson of Lakeport and Geo. P. Lowe of San Francisco have been working on the project some time. Mr. Lowe has acquired the holdings of A. H. Spurr in the three companies. R. T. Polk of Upper Lake has taken over H. V. Kelling's interest. Otherwise the personnel of the companies remains about as it was at the time of their organization. Mr. Lowe has made extensive tests of the Kelseyville gas and finds that it is not suitable for lighting purposes, nor for other domestic uses, because it contains a too large percentage of carbon dioxide. But the gas can be and will be used for driving the gas engines with which electrical power will be generated. The principal machinery will be ordered from the East and can not be had in less than sixty or ninety days.

FINANCIAL.

San Francisco.—The Northern Electric Railway Company has filed a certificate of increase of bonded indebtedness to $25,000,000, the money to be used for general development and improvement purposes. The directors of the company are Henry A. Butters, Louis Sloss, P. B. Lilienthal, E. J. de Sabla, W. P. Hammon and David E. Edwards.

Vallejo, Cal.—Steps are to be taken by the trustees to complete the water supply of the municipal system and it is expected that an election to issue bonds to the amount of $60,000 will be called in the near future. The plan is to build a second reservoir on the Nelson and Livers ranches in Wild Horse Valley, fifteen miles from Vallejo, and to impound an additional 400,000,000 gallons of water annually.

San Rafael.—A condemnation suit has been filed in the Superior Court of Marin County by the North Coast Water Company of Mill Valley against William Kent of Kentfield, for the purpose of condemning a watershed of 670 acres located in Redwood Canyon, Mill Valley, which Kent refuses to sell. The complaint alleges that unless the water company possesses the water rights to the property in question it will be unable to furnish Mill Valley and vicinity with an adequate water supply.

Glendale, Cal.—At the last general meeting of the Tropico Water Company it was decided to buy the pumping plant now owned by Dwight Griswold and the land on which it is situated and also the large reservoir site which lies at the eastern end of Reposia Court in the eastern part of Tropico. A resolution was adopted by which it was decided to issue gold bonds to the amount of $25,000 about the first of January. The purchasing of this pumping plant will greatly improve the water system.

San Francisco.—An opinion has been given by Attorney-General U. S. Webb, denying the application of John Agar for permission to maintain an action in the name of the State of California against the Home Telephone Company of San Francisco for the purpose of having the franchise that was granted to the telephone company in April, 1906, declared void and canceled. While assuming that the contentions of the applicant could be supported by evidence, Attorney-General Webb holds that it is doubtful if any of them are sufficient in strength to cancel the franchise and that it is not necessary to go into the legal issues involved, but bases his denial of the petition on the provisions of the act of the Legislature under which the franchise was granted.

INCORPORATIONS.

San Francisco.—The Keith & Mack Oil Company has been incorporated with a capital stock of $20,000 by J. M. Keith, I. Mack, I. Guggenhime, A. Mack and H. Steinback.

Oakland, Cal.—Articles of incorporation have been filed by the Fairbanks Oil Company with a capital stock of $25,000 by J. C. Merriam, M. P. Albee, W. J. Acheson, Francis Ferrier and H. W. Fairbanks.

Hanford, Cal.—S. B. Johnson, J. T. Dunlap, W. F. Kelley, F. X. Beck and F. W. Waechter have filed articles of incorporation of the Four Thousand Oil Company. The capital stock is $100,000.

Los Angeles, Cal.—The Consolidated Mining, Water & Power Company of Los Angeles has been incorporated. The capital stock is $500,000, and S. W. Thompson, W. W. Jenkins, T. J. Griffin, B. F. Masten and C. S. McKelvey are the incorporators. The place of business is Goldfield, Nev.

TELEPHONES.

Toppenish, Wash.—A contract has been let for the construction of a telephone line connecting Fort Simcoe and other towns in the valley.

Centralia, Wash.—The application of H. D. Clark for a permit to set poles and construct a telephone line along certain county roads was granted.

Wardner, Idaho.—An application was received from the North Fork Telephone Company for a franchise enabling them to transact their business in the city. The ordinance passed granting the franchise.

Anacortes, Wash.—The Farmers' Mutual Telephone Company is rushing work on their interurban lines between this city and Bellingham and Seattle, and the manager expects to have everything in first-class running order by February.

Walla Walla, Wash.—National Forest Telephone Expert A. Darling passed through the city Saturday en route to the Toll Gate and Umatilla River, where he will investigate the feasibility of establishing a telephone system for the use of people residing in that part of the national forest. Mr. Darling has recently completed arrangements for the establishment of a forest telephone system in the Imnaha National Forest north of Baker City, Ore. When he returns from the Toll Gate, Mr. Darling will go to Dayton to inspect a proposed line from there east to Two Canyons near Peola.

Dayton, Wash.—The working out of plans now under consideration means that Dayton, Wash., and the wheat belt in the Walla Walla district, southwest of Spokane, will be part of the system which the Independent Telephone Company is organizing throughout the Pacific Northwest. The movement is supported by the Dayton Commercial Club and many of the prominent business men of the city. J. E. McGillivray, a representative of the Independent interests, and W. J. Brownell will organize a stock company to install the plant, which will have connections with Walla Walla and the surrounding towns in the district.

Ashland, Ore.—Mr. Carroll, representing the Pacific States Telephone Company, was before the Council and requested that body to extend a franchise to his corporation for the term of ten years. The Council agreed to extend the franchise in the event of reaching a basis of mutual understanding with said company, the city to derive an annual revenue of sixty cents per phone and the privilege of the use of a certain number of phones at the rate of $1.25 per year each, also reserving the right to regulate rates, provide for the placing of wires underground and other minor requirements. Inasmuch as the petitioners had men and material on the ground, on their urgent request permission was granted informally to go on with the work, subject to acceptance by the telephone company of conditions imposed by the Council, and in the event of noncompliance all proceedings to be void.

CLASSIFIED LIST OF ADVERTISERS

Air Compressors
Hunt, Mirk & Co.

Alternators
California Electrical Works

Aluminum Electrical Conductors
Pierson Roeding & Co.

Annunciators
Electric Appliance Co.
California Electrical Works.
Century-Klein Electric Co.
Holtzer-Cabot Elec. Co.
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Asbestos Products
Johns-Manville Co., H. W.

Batteries, Primary
California Electrical Works

Batteries, Storage
Western Electric Co.
Century-Klein Electric Co.
Electric Storage Battery Co.
Tel. and Elec. Equipment Co.

Boilers
Moore, C. C. & Co., Inc.
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O. C. Goeris & Co.
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Conduits
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Electric Appliance Co.
Tel. and Elec. Equipment Co.
Century-Klein Electric Co.

Conduit Fixtures
Century-Klein Electric Co.
Electric Appliance Co.
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Cooling Towers
O. C. Goeris & Co.
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Cross Arms
Century-Klein Electric Co.
Electric Appliance Co.
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Dynamos and Motors
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California Electrical Works
Crocker-Wheeler Co.
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Elevators
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Electric Car Heaters
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Northern Electrical Mfg. Co.

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California Electrical Works
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Electric Heating Devices
Electric Appliance Co.
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Electrical Instruments
Electric Appliance Co.
Cutter Co., The
Century-Klein Electric Co.
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Johns-Manville Co., H. W.
Tel. and Elec. Equipment Co.
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Pierson, Roeding & Co.
Johns-Manville Co., H. W.

Electrical Supplies
California Electrical Works
Century-Klein Electric Co.
Electric Appliance Co.
Johns-Manville Co., H. W.
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Electric Ventilating Fans
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California Electrical Works
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Engines, Boilers, Heaters, etc.
Moore, Chas. C. Co., Inc.

Electric Watchman's Clocks
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Westinghouse Machine Co
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Westinghouse Machine Co.
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California Electrical Works
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Hunt, Mirk & Co.
Century-Klein Co.
Copeland, Clem A.
Cory, C. L.
General Electric Co.
Hunt, Dillman, Meredith & Allen
Jackson, D. C. & W. M.
Smith, Emery & Co.